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The Influence of Emotional States on the Functions of the Alimentary Canal.

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THE INFLUENCE OF EMOTIONAL STATES ON THE FUNCTIONS OF THE ALIMENTARY CANAL.[1]

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The contraction of bloodvessels with resulting pallor, the pouring out of "cold sweat," the stopping of salivary secretion so that the "tongue cleaves to the roof of the mouth," the dilatation of the pupils, the erection of the hairs, the rapid beating of the heart, the hurried breathing, the trembling and twitching of facial muscles, especially those of the lips—all these bodily changes are well recognized attendants of major emotional disturbances, such as fear, horror, and deep disgust. It is well known also that these changes occur chiefly in structures supplied with smooth muscle and innervated through the sympathetic nervous system. But these bodily emotional alterations, commonly noted, are mainly superficial and readily observable. Even the increased rapidity of the heart beat manifests itself in the periphery. There are, however, other viscera, supplied with smooth muscle and innervated by sympathetic fibers, which are hidden deeply in the body and which do not reveal so obviously as do the structures already mentioned the disturbances of function accompanying affective states. Special methods must be used to determine whether these organs also are included in the complex of an emotional agitation.

The bladder, for example, as Mosso has shown, is extraordinarily sensitive to mental states involving interest and attention.[2] That the tone of the bladder is much increased during excitement might be inferred from the common experience of soldiers before moving into the firing line, of students facing the ordeal of an examination, of speakers about to go before an audience—in all these instances the increasing tone of the bladder muscle makes an insistent demand. The observations of the physiologist have merely refined these general experiences and made clear the paths of the nervous impulses

[1] In the use of the term "emotion" in this paper the meaning is not restricted to violent affective states, but includes "feelings" and other affective experiences. The term is also used in the popular manner, as if the "feeling" preceded the bodily change.

[2] Decennial Celebration, Clark University, 1899, p. 396.

and the degree of sensitiveness of the peripheral organ to excitation in the central nervous system.

The development of our knowledge of the relations of emotions to the functioning of the alimentary canal is similar. There are references in medical and other literature to the effects, favorable and unfavorable, of mental states on digestion. These instances are not uncommon in the observations of medical practitioners. The recent studies by the physiologists have merely proved specifically and in detail the disorders of function which ensue when feelings are aroused. It will be of interest to note some of the conditions attended by digestive disturbances, and later the refinements of our knowledge of these conditions discovered by recent experimental work, and certain practical conclusions to be drawn therefrom.

An interesting case illustrating the influence of a mental state on the activities of the alimentary canal is given by Burton[3] in his *Anatomy of Melancholy*. "A gentlewoman of the same city saw a fat hog cut up, when the entrails were opened, and a noisome savour offended her nose, she much misliked, and would not longer abide; a physician in presence told her, as that hog, so was she, full of filthy excrements, and aggravated the matter by some other loathsome instances, insomuch this nice gentlewoman apprehended it so deeply that she fell forthwith a vomiting, was so mightily distempered in mind and body, that with all his art and persuasion, for some months after, he could not restore her to herself again, she could not forget or remove the object out of her sight." Truly, here was a moving circle of causation, in which the physician himself probably played the part of a recurrent augmenter of the trouble. The first disgust disturbed the stomach, and the disturbance of the stomach, in turn, aroused in the mind greater disgust, and thus between them the influences continued to and fro until digestion was impaired and serious functional derangement supervened. The stomach is "king of the belly," quotes Burton, "for if he is affected all the rest suffer with him."

Müller[4] has reported the case of a young woman whose lover had broken the engagement of marriage. She wept in bitter sorrow for several days, and during that time vomited whatever food she took. But not all cases are so severe in their visceral manifestations as this. Sometimes the conditions of mental discord are merely attended by a sense of gastric inertia. For example, another patient described by Müller testified that anxiety was always accompanied by a feeling of weight in the epigastrium, as if the food remained in the stomach. Every addition of food caused an increase of the trouble. Strong emotional states in this instance led almost always to gastric distress, which persisted, according to the grade

[3] The Anatomy of Melancholy (first published in 1621), London, 1886, Part I, p. 443.

[4] Deut. Arch. f. klin. Med., 1907, lxxxix, 434.

and the duration of the psychic disturbance, between a half hour and several days. The patient was not hysterical or neurasthenic, but was a very sensitive woman deeply affected by moods.

These cases are merely illustrative, and doubtless can be many times duplicated in the experience of any physician concerned largely with digestive disorders. Indeed, the opinion is expressed that a large percentage of the cases of gastric indigestion that come for treatment are functional in character and of nervous origin. It is the emotional element that seems most characteristic of these cases. To so great an extent is this true that Rosenbach[5] has suggested that as a characterization of the etiology of the disturbances, "emotional dyspepsia" is a better term than "nervous dyspepsia."

In recent physiological studies of the alimentary canal the importance of emotional states to normal digestion has received striking confirmation. The motility and the secretory activity have both been proved to be closely dependent on the nature of the excitation in the central nervous system. Pawlow's well-known observations showed the importance of appetite and a relish for food in starting the secretions of the stomach. These observations on dogs have been almost completely confirmed by studies of human beings having œsophageal obstruction and gastric fistula. Hornborg,[6] Cade and Latarjet,[7] Bogen,[8] and others have reported in detail studies of such cases. Hornborg found that when the boy whom he studied chewed agreeable food a more or less active secretion of the gastric juice was started, whereas the chewing of indifferent material was without influence.

Not only is it true that normal secretion is favored by pleasurable sensations during mastication, but also that unpleasant feelings, such as vexation and some of the major emotions, are accompanied by a failure of secretion. Thus Hornborg was unable to confirm in his patient the observation of Pawlow that mere sight of food to a hungry subject causes the flow of gastric juice. Hornborg explains the difference between his and Pawlow's results by the difference in the reaction of the subjects to the situation. When food was shown, but withheld, Pawlow's hungry dogs were all eagerness to secure it, and the juice at once began to flow. Hornborg's little boy, on the contrary, became vexed when he could not eat at once, and began to cry; then no secretion appeared. Bogen also reports that his patient, a child, aged three and a half years, sometimes fell into such a passion in consequence of vain hoping for food that the giving of the food, after calming the child, was not followed by any secretion of the gastric juice.

[5] Berl. klin. Woch., 1897, xxxiv, 71.
[6] Skandanavische Arch. der Phys., 1904, xv, 248.
[7] Jour. de phys. et path. gén., 1905, vii, 221.
[8] Arch. f. die ges. Phys., 1907, cxvii, 156.

The observations of Bickel and Sasaki[9] confirm and define more precisely the inhibitory effects of violent emotion on gastric secretion. They studied these effects on a dog with an œsophageal fistula, and with a side pouch of the stomach, which, according to Pawlow's method, opened only to the exterior. If the animal was permitted to eat while the œsophageal fistula was open, the food passed out through the fistula and did not go to the stomach. Bickel and Sasaki confirmed the observation of Pawlow that this sham feeding is attended by a copious flow of gastric juice, a true "psychic secretion," resulting from the pleasurable taste of the food. In a typical instance the sham feeding lasted five minutes, and the secretion continued for twenty minutes, during which time 66.7 c.c. of pure gastric juice was produced.

On another day a cat was brought into the presence of the dog, whereupon the dog flew into a great fury. The cat was soon removed, and the dog pacified. Now the dog was again given the sham feeding for five minutes. In spite of the fact that the animal was hungry and ate eagerly, there was no secretion worthy of mention. During a period of twenty minutes, corresponding to the previous observation, only 9 c.c. of acid fluid was produced, and this was rich in mucus. It is evident that in the dog, as in the boy observed by Bogen, strong emotions can so profoundly disarrange the mechanisms of secretion that the natural nervous excitation accompanying the taking of food cannot cause the normal flow.

On another occasion Bickel and Sasaki started gastric secretion in the dog by sham feeding, and when the flow of gastric juice had reached a certain height, the dog was infuriated for five minutes by the presence of the cat. During the next fifteen minutes there appeared only a few drops of a very mucous secretion. Evidently in this instance a physiological process, started as an accompaniment of a psychic state quietly pleasurable in character, was almost entirely stopped by another psychic state violent in character.

It is noteworthy that in both the positive and negative results of the emotional excitement illustrated in Bickel and Sasaki's dog the effects persisted long after the removal of the exciting condition. This fact Bickel[10] was able to confirm in a girl with œsophageal and gastric fistulas; the gastric secretion long outlasted the period of eating, although no food entered the stomach. The importance of these observations to personal economics is too obvious to require elaboration.

Not only are the secretory activities of the stomach unfavorably affected by strong emotions; the movements of the stomach as well, and, indeed, the movements of almost the entire alimentary canal,[11]

[9] Deut. med. Woch., 1905, xxxi, 1829. [10] Berl. klin. Woch., 1906, xliii, 845.

[11] The lower part of the large intestine may have an increased activity during excitement, so that there is involuntary voiding of the gut. See Darwin, Expression of Emotions in Man and Animals, New York, 1873, p. 77.

are wholly stopped during excitement. In my earliest observations on the movements of the stomach[12] I had difficulty, because in some animals the peristalsis was perfectly evident and in others there was no sign of activity. Several weeks passed before I discovered that this difference in response to the presence of food in the stomach was associated with a difference of sex: the male cats were restive and excited on being fastened to the holder, and under these circumstances gastric peristalsis was absent; the female cats, especially if elderly, submitted with calmness to the restraint, and in them peristaltic waves took their normal course. Once a female with kittens turned from her state of quiet contentment to one of apparent restless anxiety. The movements of the stomach immediately stopped, and only started again after the animal had been petted and had begun to purr. I later found that by covering the cat's mouth and nose with the fingers until a slight distress of breathing occurred, the stomach movements could be stopped at will. Thus, in the cat any sign of rage, such as Bickel and Sasaki's dog manifested, or distress, or mere anxiety, was accompanied by a total cessation of the movements of the stomach. I have watched with the *x*-rays the stomach of a male cat for more than an hour, during which time there was not the slightest beginning of peristaltic activity, and yet the only visible indication of excitement in the animal was a continued to-and-fro twitching of the tail.

What is true of the cat has been proved true also of the rabbit, dog, and guinea-pig—even slight psychic disturbances were accompanied by stoppages of peristalsis.[13] My observations on the rabbit have been confirmed by Auer,[14] who found that the handling of the animal incident to fastening it gently to a holder stopped gastric peristalsis for a variable length of time. And if the animal was startled in any way, or struggled, peristalsis was again abolished. The observations on the dog also have been confirmed; Lommel[15] found that small dogs in strange surroundings might have no movements of the stomach for two or three hours. And whenever the animals showed any indications of being uncomfortable or distressed the movements were inhibited and the discharge from the stomach checked.

Like the peristaltic waves of the stomach, the peristalsis and segmenting movements of the small intestine and the antiperistalsis of the large intestine all cease whenever the observed animal manifests signs of emotional excitement.

There is no doubt that just as the secretory activity of the stomach is affected in similar fashion in man and in lower animals, so likewise gastric and intestinal peristalsis are stopped in man as they are stopped in the lower animals, by worry and anxiety and the

[12] Amer. Jour. Phys., 1898, i, 380.
[13] Amer. Jour. Phys., 1902, viii, xxii.
[14] Ibid., 1907, xviii, 356.
[15] Münch. med. Woch., 1903, i, 1634.

major affective states. Indeed, the feeling of heaviness in the epigastrium commonly complained of by nervous persons may be due to the stagnation of food. That such stagnation occurs is shown by the following case: A refined and sensitive woman who had had digestive difficulties, came with her husband to Boston to be examined. They went to a hotel for the night. The next morning the woman appeared at the consultant's office an hour after having eaten a test meal. An examination of the gastric contents revealed no free acid, no digestion of the test breakfast, and the presence of a considerable amount of the supper of the previous evening. The explanation of this stasis of the food in the stomach came from the family doctor, who reported that the husband had made the visit to the city an occasion for becoming uncontrollably drunk, and that he had by his escapades given his wife a night of turbulent anxiety. The second morning, after the woman had had a good rest, the gastric contents were again examined; the proper acidity was found, and the test breakfast had been normally digested and discharged.

It is of interest to know by what paths the inhibitory impulses, which stop the movements of the stomach and intestines, pass from the central nervous system to these organs. Pflüger[16] proved many years ago that stimulation of the splanchnic nerves inhibits the movements of the intestines. Pflüger's discovery has since been confirmed by many observers. There is a difference of opinion concerning the effect of sympathetic impulses on the stomach. Most investigators have attributed to these impulses inhibitory functions alone; but Morat[17] has noted the opposite effect, and Openchowski[18] reports that in the rabbit the sympathetic has mainly a motor influence on gastric peristalsis. May[19] failed to find that stimulation of the splanchnic nerves had any effect whatever on the stomach.

Four years ago, during the course of an investigation of the motor activities of the alimentary canal after section of the splanchnic and vagus nerves, I had occasion to observe the effects of excitement on these activities after various nervous connections had been destroyed.[20] Under these circumstances such nerves as were left received impulses normally and delivered them normally to the peripheral organ. The conditions, therefore, were highly favorable for determining the course of inhibitory paths. When the vagus nerves were severed and the splanchnic nerves alone remained, respiratory distress caused the usual total cessation of the movements of the stomach and small intestine. Impulses along

[16] Ueber den Hemmungsnervensystem f. den peristaltischen Bewegungen der Gedärme, Berlin, 1857.

[17] Arch. phys., 1893, xxv, 153.

[18] Centralbl. f. Phys., 1889, iii, 4.

[19] Jour. Phys., 1904, xxxi, 264.

[20] For a preliminary notice of these results, see Cannon, Amer. Jour. Phys., 1905, xiii, xxii.

the splanchnic nerves, therefore, inhibit not only the intestines, but the stomach as well. When the splanchnic nerves were cut and the vagi alone remained, respiratory distress had no effect on the movements of the small intestine, but if prolonged until the animal began to toss about, gastric peristaltic waves became very shallow or momentarily stopped. From this evidence it would appear that the vagi convey to the stomach not only the motor impulses generally attributed to them, but also inhibitory impulses, although these latter are not nearly so efficient in stopping gastric peristalsis as are the impulses delivered by the splanchnics. When the splanchnic and vagus nerves are all cut, it is impossible to stop the movements of the alimentary canal by respiratory distress. The stoppage in the former cases cannot, therefore, be attributed to any other agency than the nervous influence, as, for example, to asphyxia.

The foregoing exposition of the influence of emotions on the activities of the stomach and intestines has shown how profoundly the mental state may affect favorably or unfavorably the secretions of the stomach, so important for the continuation of the digestive process, and how quickly and directly the mental state may entirely check the onward movement of the food. As already noted, an emotional disturbance affecting the alimentary canal is capable of starting a vicious circle; the stagnant food, unprotected by abundant gastric juice, naturally undergoes bacterial fermentation, with the formation of gases and irritant decomposition products. These, in turn, may produce mild inflammation or be absorbed as substances disturbing to metabolism, and thus affect the mental state. And the depressed mental state that accompanies "indigestion" may still further prolong the indigestion. The importance of avoiding so far as possible the initial states of worry and anxiety, and of not permitting grief and anger and other violent emotions to prevail unduly, is not commonly understood, for the subtle changes wrought by these emotional disturbances are not brought to consciousness, and are clearly known solely through physiological studies. Only as these effects are better understood can the bad results be avoided, or, if not avoided, regarded and treated with intelligence.

The influence of emotions on digestive functions is as important a consideration for the physician as it is for the patient. On the basis of this consideration Kast[21] has already pointed out the precautions necessary in order to make sure that the analysis of a test meal reveals the usual conditions of the patient. Announcing that a stomach tube is to be passed may cause serious apprehension. The tube should not be mentioned until immediately before its introduction into the œsophagus. And with easily excitable persons caution should go even farther—the meal should be eaten

[21] Berl. klin. Woch., 1906, xliii, 708.

at home with the customary surroundings, so that no disturbing element is permitted to affect the normal processes. The necessity of taking into account the psychic state in judging the results of gastric examinations is well illustrated by the case of the woman with the riotous husband, already cited. How many cases reported as showing anacidity have had such causes acting in the background?

It would probably be an error to assume a predominant importance of the psychic state in the causation of digestive disease. The facts brought forward in this paper indicate, however, that the mental state of a person complaining of digestive difficulty may have marked effects on both the motility and the secretion of the alimentary tract. The mental state of the patient, therefore, must be considered before passing judgment on the nature of his trouble, for just as feelings of comfort and peace of mind are fundamental to normal digestion, so discomfort and mental discord may be fundamental to disturbed digestion.

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